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is available at https://doi.org/10.1289/EHP6585.

Backyard Bacterial Exchange: A One Health Approach to Studying Antibiotic Resistance Transmission

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https://doi.org/10.1289/EHP6585

The ability of bacteria to develop resistance to multiple antibiotics poses a serious threat to human health.[1] Scientists are especially alarmed by the increasing failure of antibiotics known as carbapenems, which are considered the drug of last resort for treating multiple drug–resistant infections.[2] Researchers have identified carbapenem-resistant *Enterobacteriaceae* (CRE), including *Escherichia coli*, in multiple species.[3,4] However, there has been scant evidence of direct microbial transfer between humans and animals. Research published in *Environmental Health Perspectives* now provides such evidence.[5]

"In earlier research,[6] we discovered the spread of carbapenem-resistant *Enterobacteriaceae* in farm animals in China," says study author Yang Wang, a molecular biologist at the College of Veterinary Medicine, China Agricultural University. Resistant *E. coli* isolated from the farm animals and humans had similar genotypes, indicating the potential for transmission between the two.[7]

In some areas of China, large percentages of households raise livestock in their backyards, bringing humans into close contact with animals.[8] As part of the Sino-Swedish Integrated Multisectoral Partnership for Antibiotic Resistance Containment project, Wang and his colleagues thus decided to use a One Health approach to investigate CRE transmission in people, their backyard animals, and their environment.

The researchers visited 746 rural households across 12 villages surrounding a central city in Shandong Province, China. They collected fecal samples from residents and livestock. At some households, they also captured flies. Household members answered surveys about risk factors for bacterial transmission, such as the variety of animals they raised and whether they used manure as fertilizer. In addition, the researchers took samples from workers and pigs at the two commercial farms closest to the villages.

The researchers found carbapenem-resistant *E. coli* at about 9% of the households but none at the commercial farms. Households were more likely to have resistant bacteria if they used manure (human and/or animal) as fertilizer or raised a variety of animals. The researchers sequenced the DNA of the resistant *E. coli* and screened for the presence of genes that confer resistance. More than 35% of the resistant *E. coli* collected from humans shared core genomes with the bacteria from animals, and the resistance genes in *E. coli* collected from humans were almost identical to those in samples from animals.

To determine the direction of transfer between people and livestock, the researchers used a modeling approach called discriminant analysis of principal components to identify the original host of bacterial isolates. Modeling estimated that most of the resistant bacteria cultured from humans originated in dogs, chickens, pigs, or cattle. Likewise, humans, cattle, dogs, and chickens contributed most of the resistant bacteria cultured from pigs. Resistant bacteria isolated from flies came mostly from humans and dogs, chicken isolates came mostly from pigs and dogs, and the single cattle-derived isolate appeared to come from chickens.

The study's unique strength was its comprehensive simultaneous sampling of individual households, their backyard animals, and their immediate environment—represented by flies—says Qijing Zhang, a microbiologist at Iowa State University who was not involved in the study. "By analyzing a close genetic association between bacteria isolated from animals and humans in the same household, the researchers provided very good evidence that people and animals directly exchange carbapenem-resistant bacteria," he says.

The commercial farms were free of carbapenem resistance, perhaps due to better regulation of hygiene and antibiotic use, the authors suggest. But firm conclusions cannot be drawn because the scientists sampled only two commercial farms, and carbapenem resistance has been reported in other industrial livestock settings.[9,10]

The study is notable for its large scale and the way it highlights the fact that backyard farms may be an underestimated

A study of farmers, backyard livestock, and the flies that bother them all revealed that carbapenem-resistant *E. coli* can circulate among species. Images (left to right): © XiXinXing/Shutterstock; © Gadelshina Dina/Shutterstock; © Lesia Povkh/Shutterstock; © yazirmzm/Shutterstock; © Davdeka/Shutterstock; © Johnathan21/Shutterstock.

source of carbapenem resistance, says Séamus Fanning, a molecular biologist at University College Dublin who also was not involved in the study. "However," he says, "we don't really know if the resistant bacteria are coming from hospital settings to farms via the householders or whether carbapenem resistance in the farm animals' bacteria has arisen due to coselection for resistance to other, more common antibiotics."

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